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Accelerated Performance Degradation of Single-Phase Cold Plates for Direct-to-chip Liquid Cooled Data Centers

By

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Teams

Abstract

Expanding demands for cloud-based computing and storage, the Internet of Things, and AI-based applications have escalated thermal loads in high-density data centers which necessitated the utilization of more efficient cooling technologies. Direct-to-chip liquid cooling using cold plates has proven to be one of the most efficient methods to dissipate the high heat fluxes of modern high-power CPUs and GPUs. While the published literature has well-documented research on the thermal aspects of direct liquid cooling, a detailed account of reliability degradation is missing. The present investigation provides an in-depth analysis of the reliability degradation of copper cold plates used in high-power direct liquid cooling with accelerated failure conditions of flow rate and temperature. A benchtop setup is designed using a combination of different materials like Rubber tube copper cold plate, metal fittings, Instruments capable of measuring the thermal, hydraulic performance of the cold plate along with coolant chemistry (pH, ORP and Electrical Conductivity). The degradation was analyzed by time-based data for change in pH, ORP, and electrical conductivity as indicators of corrosion in the cooling loop. Non-destructive analysis of the cold plates was conducted change in channel dimensions using SEM, and microscopic analysis of the cold plate channels for copper pitting. These experimental results are presented in engineering design considerations for the construction of the flow loop and the choice of working liquid to be used.